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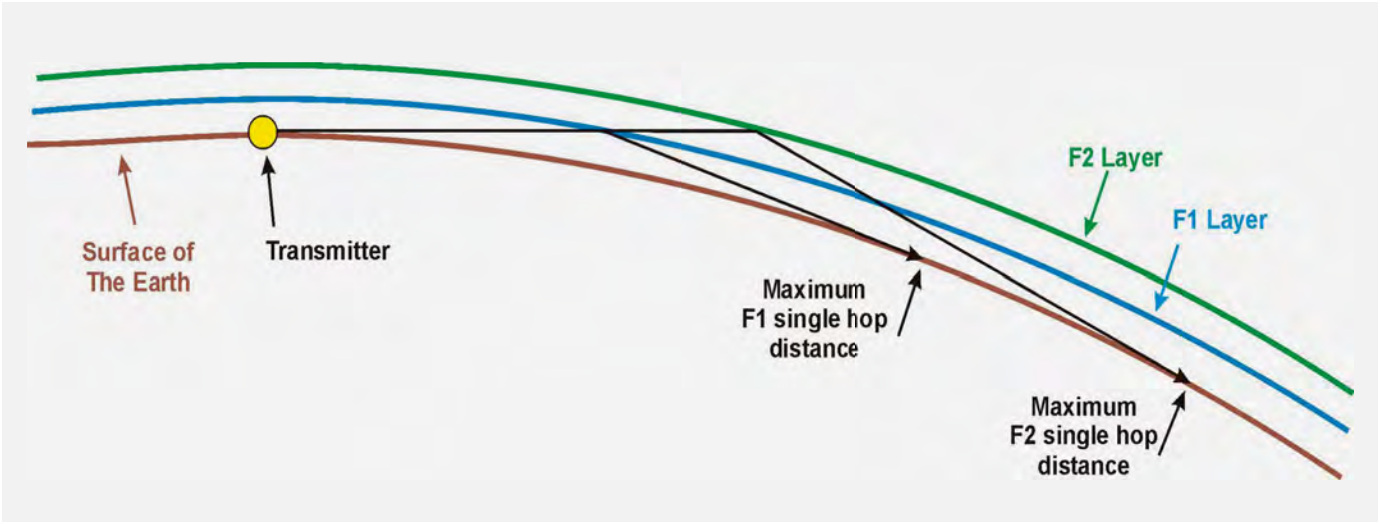

Fig. 2: The geometry of a refraction.

The F Layer

Steve White G3ZVW looks at the F layer of the ionosphere.

In total the ionosphere exists from a height of about 60km to 1000km above the Earth's surface. As I've written before (see **Fig. 1**) it has layers within it and as regards radio propagation they all do different things. This month I am going to take a look at the layer that is responsible for the longest distance refractions.

Higher Means Further

Fig. 2 is a simplified illustration of how the height at which a refraction takes place affects the maximum distance at which it will be returned to Earth. In each case I show the signal leaving the transmitter parallel to the ground and arriving parallel to the ground. Basically, it's all down to geometry. If a radio wave can make its way as far up as the F2 layer and if the F2 layer is ionised strongly enough to refract it back to the ground, it will be refracted at the maximum distance. Remember that at one end of the frequency spectrum the D Region absorbs low frequencies during the hours of daylight and the F Layer may not be sufficiently highly ionised to refract higher frequencies successfully.

Spring and Autumn

The best conditions for long distance HF propagation are often found around the times of the spring and autumn equinoxes. This is associated with the Earth's angle of tilt with respect to the Sun. It is an aspect of propagation that has been well understood for a long time, so it is no coincidence that many of the world's major HF worldwide contests take place in the spring and autumn.

Sunspot Cycle

Irrespective of the season here on Earth and other short-term solar conditions that exist, the F Layers are more strongly ionised around the peak of the 11-year Solar Cycle. As **Fig. 3** shows, we are currently way past the last Solar Maximum and fast headed towards the next Solar Minimum. Although there can be significant day-to-day variation, the ionosphere is currently far from at its best and the outlook for the next few years is gloomy.

Day/Night Changes

Like the other layers/regions of the ionosphere (see Fig. 1 again), the F layer is different at night to day.

As the figure shows, during the hours of daylight there are two F layers. These are known as f1 and f2. f2 is the higher and stronger of the two, and responsible for carrying the majority of long distance radio signals. The height of maximum ionisation is often around 300km but as a whole, the layer can exist weakly up to about 1000km.

At night the f1 and f2 layers combine and are weaker than during the day. The height of maximum ionisation of the combined F layer is usually higher than when the layers are separate.

Prove it to Yourself

Now it's 'prove it to yourself' time! For this you will need a shortwave receiver, which can either be an online Software Defined Radio (SDR) or one in your home. Select the 14MHz amateur band, tune around and listen on Upper Sideband (USB) from about 14150-14350kHz. Make a note of the countries of the stations that you hear – and repeat the exercise at different times of the day.

Mornings

During the mornings you should normally be able to hear plenty of stations from across Europe, maybe some in the Middle East (if any are active) and on days when propagation is particularly favourable, a few in the Far East. Don't expect to be able to hear anything from North or South America at this time of day. This general pattern of reception (see **Fig. 4** - the favoured directions are arrowed) is because to the East of here the Sun will have risen earlier, which will result in the ionosphere having been directly exposed to its radiation for longer – and that encourages the Maximum Usable Frequency (MUF) to build up to a higher value and thereby better support the refraction of radio waves at this frequency.

Afternoons

From late morning and into the afternoon

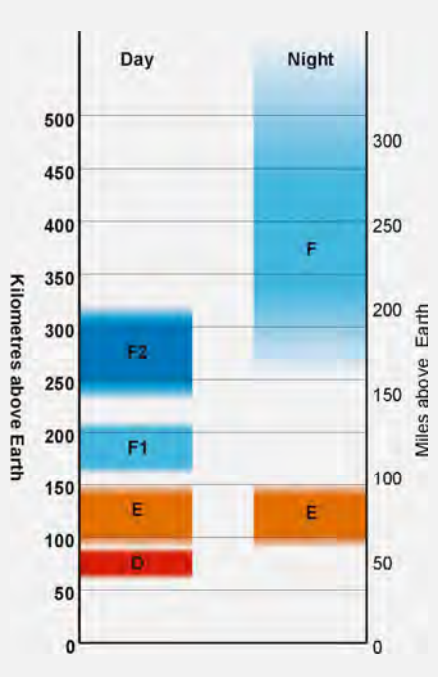

Fig. 1: A simplified view of the ionosphere.

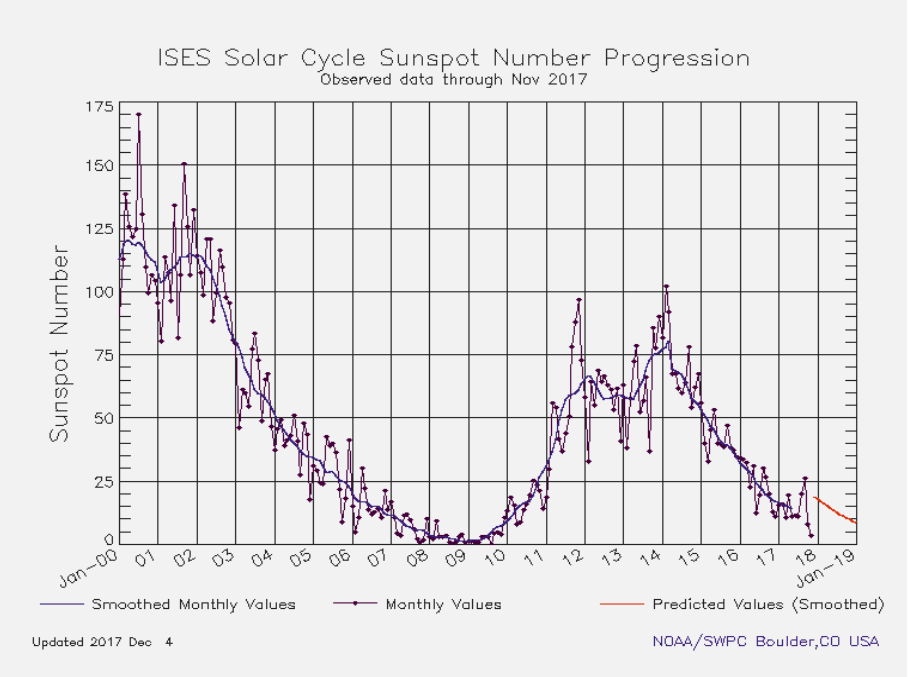

Fig. 3: Solar Cycle 24 started Dec. 2008. A very disappointing peak, and now very little solar activity.

Fig. 4: In the mornings the ionosphere is more highly ionised to the East.

Fig. 5: In the afternoon the area of highest ionisation reaches the Americas.

Fig. 6: The evening is the best time to hear the Americas.

is usually the best time to hear stations from Africa. This is because at this time the ionosphere will be at its strongest to countries that are south of Europe. Unfortunately, this goes largely to waste because there isn't a great deal of activity from the African continent.

Expect to be able to hear plenty of stations from Europe in the afternoon. You should still be able to hear any stations active from the Middle East, even though it will be approaching sunset in that part of the World. It becomes increasingly unusual to hear any stations from the Far East during the afternoons (UK time) because it is dark across that part of the World and the MUF has therefore dropped below the point at which it will support the refraction of the 14MHz signals.

As **Fig. 5** shows, during the afternoons you can expect to start hearing stations from the Americas. Stations in Eastern Canada and the North-East USA are often the first to be heard. This is because when it is afternoon in Europe it is morning in America so the radiation from the Sun is starting to build up the MUF in that part of the World. By afternoon the MUF will be starting to fall across Britain but signals from America are refracted above the Atlantic and that's where it really matters that the MUF is high.

Evenings

By the time the Sun sets across Britain it will have been dark across most of Europe for some hours. This means the MUF will have been falling for some time. As a rule you should expect European stations to fade away progressively from the East, as the evening progresses.

Our evening is the best time to hear stations from North America, although at this point of the Sunspot Cycle the band is likely to close quite early. See **Fig. 6**.

Evenings are usually the best time to hear stations from South America. This is because the MUF (and therefore propagation) on North-South paths (i.e. across equatorial regions) is usually higher than on East-West paths. The Sun makes the Earth hotter in equatorial regions because it shines down at a steeper angle and its effect on the ionosphere is similar. It needs to be pointed out that there is a lot more amateur radio activity from Latin and South America than there is from Africa. Generally speaking, any stations you hear from Central and South America will not be very strong, and you may also experience a language barrier because if they are speaking to one another, it is likely to be in Spanish or Portuguese.

Overnight

As darkness falls across the Atlantic the MUF falls with it, so stations from the Americas will fade away, if they haven't already done so. At this point in the Sunspot Cycle those of us in the UK are likely to hear very little activity from anywhere on the 14MHz band overnight. In contrast, at the peak of the cycle it is quite normal for the 14MHz band to support long-distance propagation throughout the night and the pattern I have been describing will be more applicable to the higher HF bands (the 18MHz and/or 21MHz bands, for example).